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ABSTRACT

This paper reports on a Masters level course in educational research given by Illinois State University that used instructional Internet technologies. Students were located in a public school district three and one-half hours from campus. The course utilized several in-person sessions (both on- and off-campus), e-mail, and a dedicated Web site. The majority of classes, though, were held synchronously over the Internet using CU-SeeMe client and server software. Students reported generally enjoying the class, although the multiplicity of continuing technical issues and steep computer learning curve were problems for some. Evaluation indicated that all the students passed the course, with assignment grades and test scores no different from those earned by similar on-campus students in prior semesters. However, course delivery required an enormous amount of time and technical expertise on the part of the instructor and the school district technical staff. Instructors contemplating this mode of content delivery are urged to be aware of both benefits and costs, especially in terms of time for instructor and student training, multiple modality and error-alternative preparation, and practice. (DB)

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Using CU-SeeMe to Deliver a Masters-Level Class over the Internet

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Abstract

A recent Masters level course pushed the envelope on using instructional Internet technologies. This course utilized several in-person sessions (both on- and off-campus), e-mail, and a dedicated web site. The majority of classes, though, were held synchronously over the Internet using CU-SeeMe client and server software. Certain experiences (e.g., installing and configuring new software, training students to use the software, and back-up methods of instruction) were anticipated, while others had to be dealt with on the fly (e.g., incompatible hardware, Internet propagation delays, and unsynchronized audio and video). Students reported generally enjoying the class, although the multiplicity of continuing technical issues and steep computer learning curve may make this approach unsuitable for some. Instructors contemplating this mode of content delivery need to be aware of the benefits and the costs, especially in terms of time for instructor and student training, multiple modality and error-alternative preparation, and practice.

Using CU-SeeMe to Deliver a Masters-Level Class over the Internet

Teaching courses away from campus is not a new phenomenon. Over the past few years educators have devised a variety of innovative means to reach remote students unable to attend classes at a central location (Rossman & Rossman, 1995). New technologies have provided additional means by which to reach distant students. Increasing numbers of higher education programs, including graduate-level Masters and Doctoral offerings, have been including these technologies in their education at a distance offerings. Although many of these graduate-level courses are professional rather than research in orientation (Maxwell, 1995), there has been increasing interest in using new technologies for more traditional, research graduate programs of study (Kearsley, 1995).

For the graduate student population e-mail has been (and probably continues to be) the most frequently used, and easiest to master, means of out-of-class communications (Hesser & Kontos, 1995). Other methods of distant teacher-student interaction, including telephone conference calls and electronic libraries (Mizell, 1994), provide content and interaction resources beyond what simple e-mail can muster. Direct audio conferencing has also been used (Burge & Howard, 1993), although the absence of visual cues proved a significant detriment to student interaction. Telecourses, or Interactive TeleVision (ITV) courses, have also been popular and quite successful (Garland & Loranger, 1996; Miller, 1993). Unfortunately, this means of instructional delivery create restrictions on the time and place students must be at in order to receive the instruction. ITV courses also tend to involve more expensive equipment, higher connection (dedicated line) charges, and a greater degree of technical support.

The increased proliferation of the Internet has seen an exponential growth of new course offerings via computer. Most of these courses have been asynchronous in nature, with neither students nor instructor having a particular day or time requirement for access. Synchronous Internet-based instruction has been much more limited, suffering from the lack of usable software and limited bandwidth. Several programs have been making gradual inroads into this area, providing low cost, Internet-based audio and video conferencing solutions. The most popular of these, CU-SeeMe, had been in use for several years by hobbyists and researchers for point-to-point discussions and multi-point conferences (Schrum, 1995; Barron & Orwig, 1995). Educators have begun to experiment with CU-SeeMe for actual course delivery (Todd, 1996). Internet-based audio and video conferencing programs like CU-SeeMe have the promise of low cost, ease of operation, and no need for expensive equipment or highly trained technicians at central sites.

An Experimental Opportunity

The Department of Educational Administration and Foundations, a graduate-level unit in the College of Education at Illinois State University, has as one of its primary missions the preparation of educational leaders in public schools. Accomplishing this mission often requires teaching courses off campus. One off-campus cohort draws students from a school district located approximately three and one-half hours drive from campus. The distance from campus

makes weekly travel impractical. Intensive, multi-day weekend sessions are sometimes offered, although certain courses (and instructors!) do not adapt well to this delivery format.

Dedicated-line compressed video is a popular distance education alternative that has been successfully used with other sites. Unfortunately, this school district did not have the facilities for this kind of remote site connection. Neither were facilities available for instructional delivery via satellite. Asynchronous Internet-based (web) instruction has also been used in other subject areas, although there was some concern about teaching a Masters level, research and statistics class solely asynchronously. Compressed two-way audio and video over the Internet had been used experimentally, but never as a primary means of delivering instruction. Could this new technology be used for primary instruction for this off-campus group? An opportunity for a trial arose early in the summer of 1997, for a course in the fall of that same year.

Methods

Participants

The course selected for this trial was a Masters level Introduction to Educational Research course, scheduled to be delivered to an off-campus cohort of students in the fall of 1997. This cohort, twelve elementary teachers working in the same school district, were just beginning a program of study leading to the Master of Education with a concentration in the Principalship. These students, and their school district, were located a three and one-half hour drive from the ISU campus. This distance would have made the typical weekly three hour class meeting a near impossible burden on the instructor. Monthly super-weekend sessions (meeting over two full weekend days) were rejected as being incompatible with the kind of work expected in the research class. Conducting the course using dedicated, point-to-point compressed video (ITV) was also investigated; unfortunately, the facilities did not exist at the district (or anywhere close to the district) to make this option a reality.

Early in the summer the students and their school district administrative and technical staff were consulted about the possibility of conducting part or all of the course synchronously over the Internet. While such a venture had never been tried, the school district and university administrations were excited about the possibility and supportive of the effort. Funds were made available for the purchase of the necessary hardware and software at both the school district and the university, and the students were consulted concerning specifics of the course (e.g., class scheduling, availability for travel to campus, availability for live instructor meetings at their school district, and prior experience with computer hardware and software).

Apparatus

By mid-summer of 1997 the necessary software (Cu-SeeMe version 3 and Reflector version 2.1) were purchased and installed at both the university and on three computers at the school district. The plan was straightforward. The instructor would originate the class from a computer in his office. Students would meet at the school district's Learning Center, where a minimum of three different computers would be configured for networking. A server in the

instructor's research laboratory would provide basic world wide web (http) and file (ftp) services, in addition to acting as a reflector for the conferencing software.

The CU-SeeMe (version 3) software allows for real-time audio and video interaction among up to twelve users at different locations. Audio and video data are digitized and compressed, then transmitted over the Internet. For one-on-one communications a direct connection can be established between computers. Interactions involving three or more users can benefit from the use of a reflector, special software on a dedicated server that acts as a kind of clearing house and switching mechanism for the conference. CU-SeeMe also supports real-time chat, where users can type written comments to each other, as well as a WhiteBoard application, which allows the real-time sharing of graphical images, drawings, and freehand notations. Unlike other similar applications CU-SeeMe is highly customizable and configurable, providing a high degree of flexibility under varying computer hardware and Internet propagation conditions.

The Instructor's computer was a Dell XPS/H266, a Pentium-II class computer with a 266Mhz processor, 64Mb of memory, a 21" monitor with 4Mb of video RAM, and a high-speed 16Mb token rink connection to the Internet running under Windows 95. A Panasonic Egg-Cam was used to capture the live video and audio, while a SoundBlaster compatible sound card built into the computer provided audio to the stereo speakers.

The server was a Dell XPS/H233 machine, a Pentium-II class computer with a 233Mhz processor, 64 Mhz of memory, a standard monitor with 2Mb of video RAM, and a high-speed 16Mb token ring connection to the Internet. This computer was running Windows NT version 4 (service pack one), and was using Microsoft's Internet Information Server (IIS) software for world wide web and ftp services. The CU-SeeMe Reflector software (version 2.1) was also running on this machine, providing a common meeting place for all conference computers.

Three computers were purchased for the district – all were Hewlett-Packard Vectra machines; however, these machines proved incompatible with the then-available Panasonic Egg-Cam and had to be replaced with functional clone computers. The clone machines were Pentium 133Mhz computers with 32Mb of RAM and 15" SVGA monitors, each having an audio board, speakers, and Panasonic Egg-Cam. Each of these computers was connected to the Internet using a 10Mb Ethernet.

Procedures

The first task facing the instructor was the setup, installation, and testing of the various hardware and software components. Different transmit and receive bandwidths, audio and video CODECs, and connections strategies were experimented with over the course of almost two months of trials during the summer of 1997. While higher data rates provided larger images, sharper image quality, higher video frame rates and clearer audio, these rates were not always maintainable over the Internet. Tests were conducted both on campus, and between the instructor's computer on campus and the three student computers in the school district, on different days and at different times of the day. Several sets of different combinations of CODECs and transmission/receive data rates were enumerated and associated with varying

degrees of success under these changing network conditions. It was determined that no one setting would work optimally under all conditions; thus, the instructor and the students had to be willing (and able) to change key settings throughout a class as the instructional needs, and prevailing networking conditions, changed.

During this same time period the instructor was reformatting courseware for this new model of delivery. To facilitate the evaluation of this course the instructor kept a daily diary, recording his observations and experiences. Students were encouraged to e-mail the instructor detailing their impressions, as were the technical staff assisting with the project. These written records, along with the materials developed for and used in the course, were examined as the record of the course activities.

Results

The class began in mid-August of 1997 with two days of on-campus orientation sessions. During this time students were introduced to the technology of CU-SeeMe, along with a review of basic computer operations and WWW/e-mail over the Internet. Students also received the first six hours of content instruction in the research course. This session proved to be invaluable for two reasons. First, it clearly established a beginning technical level for all students. While additional computer learning was necessary throughout the course (in fact, proving to be one of the greatest distractions of this methodology), this initial session instilled a basic confidence into the participating students. Second, the on-campus session allowed the instructor to interact, live and in-person, with each student for an extended period of time. This initial bonding helped the students to feel comfortable in relating problems, questions, and other issues to the instructor later on in the course over the more impersonal technical links.

Three weeks after this initial on-campus session, the first class over the Internet using CU-SeeMe was held. Technical problems with the Hewlett-Packard computers prevented the students from utilizing all three computers, with the result being that all of students had to crowd around a single computer. These problems occurred despite almost daily, error free testing during the two weeks prior to the class! A projection system was quickly brought in to the Learning Center classroom, although the degree of class interaction initially suffered since the instructor was unable to see or hear all of the students in the class. When the HP machines were later replaced with clone compatible computers those technical problem went away. Later sessions were able to utilize all three student computers (with three to four students sharing each computer) running simultaneously.

Unfortunately, start-up problems continued to abound. Early sessions were plagued with difficulties in transmitting audio, and many times the back-up system of a speaker telephone (and resulting long-distance telephone call) had to fill in for the non-transmitting (or poor quality) audio. This solution, unfortunately, tended to put the audio badly out of sync with the video, with the video lagging the audio by as much as 12 seconds (due to Internet propagation delays).

Lagging audio also created difficulties in the viewing of pre-recorded video clips over the system. During the summer the instructor had created several short videotaped segments, which

were to be inserted into the originating CU-SeeMe audio/video stream as an augment to the image and voice of the instructor. Although there were no technical problems in switching over the audio and video signals from the live camera to the VCR, the non-synchronization of audio and video by CU-SeeMe in transmission most often resulted in a very confusing presentation for the students. Audio almost always lagged behind the video, sometimes by just a few seconds while at other times by as many as 12 seconds. For reasons unknown the audio would sometimes stop completely, or would be heard ahead of the video! After a few attempts and much disappointment the instructor gave up showing videos over the CU-SeeMe link, instead opting to encode videos using the RealVideo system, making them available for viewing by the students using the RealPlayer software. This prevented students from watching the videos during live classes, but resolved the out-of-sync issues. [NOTE: The Real system uses a buffered technology different from that of CU-SeeMe, assuring synchronization of audio and video but only in a unidirectional transmission.]

Initially all of the student computers were placed in a single, large room, the idea being that this would allow for easier interactions among the students. Each computer had its own speakers. Despite their common physical location the transmitted audio packets would arrive at each computer at slightly different times. The resulting out-of-sync and out-of-phase received audio from the instructor was, as one student described, "completely unintelligible." Students working from multiple computers in the same room had to turn down (or off) the audio on all but one machine to avoid this problem. A similar problem occurred with transmitted audio originating in the student classroom. Continuously open microphones was preferred, as this arrangement would have allowed the instructor to hear all student talk. The CU-SeeMe software has some echo-canceling capabilities, although it proved insufficient to handle the multiple computers each having open (always on) microphones and speakers. Students eventually resorted to push-to-talk system, where their microphones were only active when a certain button was pressed. This decreased spontaneity, and often left the instructor out of the loop when he could see students talking to each other (video the transmitted video) but could not hear them!

During one class the server computer crashed. This resulted in a 15 minute break while the server was rebooted and the reflector software reinitialized. Students had been previously warned that this might happen, and were contacted by phone to stand by until the server was rebooted and the connections reestablished.

Another session had to be canceled entirely when an MCI switching node, located between the campus and school district, was experiencing difficulties. Rather than just being completely out of commission, this switch was holding packets approximately 400 milliseconds before passing them on (the normal was in the range of 20 to 40 milliseconds). While this might not sound like a long time the delay dramatically degraded the audio and video transmissions to the point where neither was intelligible.

One session was ended early when the Whiteboard application, which had been running perfectly for almost two hours, crashed right before the final example was to be completed. While several of the remote students had been saving and printing the Whiteboard work as it was produced the last work was completely lost (and the Whiteboard did not want to restart without

completely rebooting each connected computer). The instructor recreated the entire Whiteboard work the next day, posting it as web pages for students to examine.

By the end of the semester operations were running relatively smoothly, and most of the kinks had been worked out. Reliable connections could be established between the university and the school district, and audio and video were configured to allow reasonable communications under almost every network circumstance. Although minor software glitches continued to occasionally crash programs (or disconnect computers from the reflector conference) the instructor and students had learned to take these problems in stride, rebooting the computer and/or application or reconnecting the computer with only minimal downtime.

The simultaneous chat window proved to be quite useful, with students able to ask questions of the instructor without interrupting the flow of a lecture or discussion. For this the instructor had to learn to respond (by typing or in voice) to these typed queries while continuing with a simultaneous audio and video presentation! It was observed that chat was used as frequently for content related needs (e.g., "what was the web address again", or "could you give us an example of what you just said") as for non-content related needs (e.g., "the audio is too low", or "I will miss class next week").

Conclusions

All of the students passed the course, with assignment grades and test scores no different from those earned by similar on-campus students in prior semesters. This method of delivery, however, proved to require an enormous amount of time and technical expertise on the part of the instructor and school district technical staff. Without that technical competence, and a willingness on the part of everyone (including the students) to tolerate, and recover from, the numerous technical glitches that occurred, the course would not have ended as well as it did. Those considering relying on CU-SeeMe as a primary means of instruction should consider the following recommendations:

1. Instructors and students need a lot of time to become familiar and comfortable with the technology – hardware and software – used in this kind of distance education. The initial orientation session was critical, although we found that additional time still needed to be spent throughout the course to refresh and expand knowledge.

2. Instructors need to plan for the unexpected, and have alternative and backup methods for delivering course content in the event of a failure of the primary method. The speaker phone provided an instant link between the university and the school district, critical at the start of each session and when technical glitches severed the connection. Having additional session dates and times written into the syllabus, as well as alternative modes of presentation (whether over a web site or in person), provided needed flexibility.

3. Instructors need to create multiple and repetitive modes of content delivery. We discovered, for example, that CU-SeeMe was not an appropriate vehicle for delivering videotaped presentations. Rather than deliver videos using CU-SeeMe it was decided to

encode the videos for presentation using RealPlayer .Likewise, we learned (the hard way, unfortunately) that content shown on the Whiteboard needed to be mirrored (using PowerPoint shows) on the web site, providing students a secondary means of viewing this content and protecting against unexpected program or system failure during class.

4. Finally, the current state of this technology requires that potential instructors and students be highly technically savvy as well as fault tolerant. The emergent nature of these new technologies, together with the unpredictability of the Internet (and, in some cases, the unexpected failure of software components) will require a need for the instructor to be able to think and act relatively quickly with a high level of technical knowledge and skill.

CU-SeeMe holds great promise as one means of delivering synchronous instruction using audio and video over the Internet. Although not yet mature enough, in our opinion, to be relied upon as the sole means of distance education instruction, Internet-based audio and video conferencing can fill a developing niche for off-campus student needs. This course has demonstrated that the software can work, albeit with continuing problems. Until those problems are resolved – with improved software and greater Internet bandwidth – conferencing applications like CU-SeeMe might best be used for occasional, small group or one-on-one interactions, or as an augment to another means of education at a distance.

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